Accounting for As-Yet Unrecognized Transient Quasi-Geometric Formations of Atmosphere in the Upper Troposphere for Improved Forecast Models

20 July 2023
Simon Edwards
Research Acceleration Initiative

Introduction

Clues as to how our own weather forecasting capability may be improved lie in photos from the Juno space probe and its exquisite photographs of Jupiter's atmosphere. Jupiter's polar regions feature stark, seemingly unnatural geometric shapes including hexagons, septagons, and octagons. While this may seem to be unnatural to some, these formations are an entirely natural consequence of the rapid cooling (and contraction) of gasses after entering the upper part of Jupiter's atmosphere. While some astronomers choose to continue to engage in wild speculation about this topic and insist that the "jury is still out" on this subject, the cause couldn't be simpler.

While the Earth's atmosphere does not feature the extremes of pressure, temperature, and wind velocity observed of that of the planet Jupiter, the basic principle that a rapidly cooling body may take on a geometric characteristic applies to the Earth as much as it does to Jupiter.

Current global forecasting models hold as a fundamental assumption that atmospheric features will always take on a circular characteristic, as is generally true of low and high pressure centers. In the absence of a complete, real-time snapshot of the entire atmosphere, general assumptions about atmospheric dynamics can be helpful to help models to fill in the blanks. However, these assumptions should be verified as accurate before being incorporated in global models. I have identified one such assumption that I believe to be inaccurate based upon its conflict with established laws of fluid dynamics, particularly with regard to rapidly cooling bodies.

Abstract

Masses of air in the upper troposphere (and above) do not, as is currently widely believed, exclusively consist of circular-shaped air masses. As warm air rises and cools, these masses, in fact, take on loosely geometric features such as occasionally flat facets at the boundaries of the newly cooled air mass.

Profoundly, the dynamics of a geometric or quasi-geometric air mass as it interacts with surrounding atmosphere, primarily with the layer immediately below, would be quite distinct from the currently assumed dynamic. This difference could even partially account for why it is that specific members of ensemble models tend to be highly accurate in retrospect. Many possible atmospheric anomalies are allowed for between the myriad members. Unfortunately, these models do not understand "why" anomalies exist, nor can

they trace the source of these anomalies. As a consequence, an opportunity is being overlooked to account for some of these anomalies.

Specifically, a geometric air formation such as a 6-sided air mass in the upper troposphere would, as it "sank" (as part of an inverse oscillation after its rise,) would, rather than consisting of a single, wide vortex of cool air sinking, would tend to consist of multiple (one for each point on the shape,) narrower vortices each of which would have discrete effects on geospatially segregated sectors of the model's grid.

This as-yet-unrecognized dynamic would significantly affect actual atmospheric dynamics in a way that tends to atrophy the accuracy of models that do not take this into account.

To take advantage of this effect, one must develop a model that allows for scenarios in which sufficiently large pockets of warm air may balloon into the upper atmosphere and take on geometric or quasi-geometric characteristics on a transient basis and subsequently follow multiple, discrete pathways back into the lower atmosphere upon reflexively falling back toward the Earth. This stands opposed to the current models' assumption: That these air masses feature marginal reflexive sinking with a single pathway for intermixing.

Additionally, it would be helpful to know in what relative direction these facets face. This element may be more difficult to assess than the validity of my own hypothesis, which should be a trivial matter. A sensible approach would be to seek out these geometric configurations in the atmosphere above Earth's polar regions as an initial step toward verification of the hypothesis. The facets might be expected to face in the direction of neighboring high pressures (upper atmospheric highs as opposed to ground-level highs) just outside of the polar regions. Making correct assumptions concerning the existence or non-existence of these facets as well as their directional orientation would be crucial to using this understanding to improve existing models. Sinking cool air might be expected, in accordance with my hypothesis, to move laterally somewhat (in addition to sinking) away from the center of the cooled air mass and for the individual vortices to slightly curve to either one side or another of the neighboring (upper level) high pressures. The position of those high pressures at the moment of the passage of the warm pocket of air into the upper atmosphere would determine the orientation of the facets of these air masses, but the position of those high pressures during the sinking phase would determine the direction of the curvature of individual streams of sinking air; an essential element for which we must account. Allowances would need to made for scenarios with facet counts ranging from 5-8 and for these shapes to be "imperfect" with the length and angle of these facets varying substantially.

Conclusion

Correcting for this gap in present-day models would have a near-zero cost as it would principally require monitoring only the polar regions for occasional

"burps" of warm air which would generate these formations and introduce anomalous influences on the actual atmosphere.

The potential benefits to model accuracy, if these assumptions are proven correct, would be substantial.